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ABSTRACT

A study investigated the validity of three theories in predicting the structure of language tone systems containing level tones. The theories include the following: that (1) phonetic elements are arranged so they are maximally separated in a fixed phonetic space; (2) a system with a larger number of phonetic elements will use a larger phonetic space to contrast the elements; and (3) as the number of elements becomes larger, additional parameters are added to the phonetic space to distinguish the elements. An analysis of level tones was performed on tone loans in three Hausa languages (Gwari, Nupe, and Kpan) and Xu and on the speech of five male native speakers of at least one African language with two level tones and one language with three level tones. It is concluded that tones are not separated according to a maximal spacing principle, but that a larger number of contrasting elements will occupy a larger phonetic space than will a smaller number. However, different phonetic subsystems may differ in the way that this expansion is achieved. Another striking finding is that tone borrowing is often shaped by the surface phonology of the donor language. A 55-item bibliography is included. (MSE)

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TONE SPACING

Ian Maddieson

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1 Introduction

Phoneticians for some time have asked questions about the relationship between the number of elements in the sound system of a language and the way that these elements are arranged in 'phonetic space.' (This phonetic space is usually thought of as a multidimensional region defined by phonetic parameters related to physical properties of an articulatory or acoustic nature.) On the one hand, it has been said that phonetic elements are arranged so that they are maximally separated in the relevant phonetic space. Consequently, the larger the number of contrastive elements, the more closely crowded together they will be in the phonetic space; for example, a language with nine vowels will have them more closely crowded together than a language with only five (Liljencrants and Lindblom 1972). On the other hand, it has been proposed that a system with a larger number of elements will use a larger phonetic space to contrast the elements (Jaeger and Van Valin 1982, Disner 1983); that is, more extreme values of the same parameters will be used when a larger number of elements are being contrasted than is the case when fewer are involved. A compromise view proposes that a principle of maximal separation may govern the use of certain more basic parameters

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but that as the number of elements becomes larger, additional parameters are recruited to distinguish the elements (Maddieson 1979, Lindblom and Maddieson 1988, Lindblom 1988). That is, the dimensions of the space itself are enlarged by the addition of these new parameters. The purpose of this paper is to address the question of which (if any) of these theories predicts the structure of tone systems containing level tones.

If we consider only the degree of pitch contrast used for distinguishing level tones in like contexts, the first hypothesis would predict level tones maximally separated in the relevant part of the speaker's pitch range (it is assumed that some part is 'reserved' for intonational and expressive variation of pitch). In this case, the two tones in a language with only two levels would be produced towards the extremes of the pitch range. In a language with three level tones, the mid tone would be produced in the centre of the overall pitch range. Additional tones would subdivide the pitch range further. If this relationship holds, the pitch range to be used is assumed to be known and it is the size of the interval between tones that is determined by the number of levels. According to the second hypothesis, we might expect that there is a more-or-less fixed interval, relative to a speaker's range, which serves as a satisfactory degree of contrast between levels. In a language with only two level tones, these tones would be separated by this interval. In a language with three tones, the highest and lowest would be separated by twice this interval, and so on. In other words, the range of pitch for paradigmatically contrasting tones would be determined by the number of level tones in the language. We should emphasise that the spacing being discussed here is within an abstract phonetic space that represents a normalisation away from the influences of individual speakers and contexts.

In previous discussion of tone spacing views which basically correspond to the above hypothesis have been put forward. We will label one of these the Pikean view. In his book *Tone Languages*, Pike (1948) expressed the opinion that "a language with two registers tends to have the contrastive levels further apart than are the

contrastive levels of four-register systems." He illustrates his view of this tendency with the diagram in (1):

(1)

2 level	3 level	4 level
High	High	High
	Mid	Mid
		Norm
Low	Low	Low

The diagram indicates further that, in Pike's view, the High and the Low tones in languages with two, three or four tones can be on the same level, whereas additional tones will be "inserted" between these levels. In other words, the overall range used for tonal contrast is the same and the *interval* between the tones is determined by how many there are. Among earlier authorities, Westermann and Ward (1933) seem to agree with this observation, and a similar view seems to underlie the tone letter notation and numerical transcription for tones proposed by Chao (1930). In an influential early article on tone features, Wang (1967) also indicates that larger numbers of tone levels are more narrowly separated than smaller numbers of tones. As he put it "the greater the number of distinct tones in the paradigm, the narrower the phonetic range of each tone would be." (This proposal also seems to encompass the view that wider phonetic variability will accompany a smaller number of distinctions.)

In a survey of tone universals (Maddieson 1978) I took essentially the opposite viewpoint. In this view, there is a more-or-less fixed interval between paradigmatically neighbouring tones, and the *pitch range* used for contrast between the set of tones is determined by the number of levels (at least for the majority of languages). Possible tone systems would include those which are represented by the diagram in (2):

(2)

2 level	3 level	4 level	5 level
		H ———	H ———
H	H ———	HM ———	HM
L	M ———	M ———	M
	L	L ———	LM
			L

This situation was summarised as (3) in Maddieson (1978).

(3) A larger number of tone levels occupy a larger pitch range than a smaller number.

Besides these extremes, some authors have put forward intermediate proposals. Woo (1969) suggests that systems with two or three level tones will separate those tones by a fixed interval, but that systems with four or five level tones will divide the upper and/or lower portion of the speakers' pitch range into smaller intervals. Hombert (1978) makes a similar suggestion, although the model of tone system structure which he puts forward does not fully implement this proposal but instead incorporates a Pikean view of the situation.

The question at issue, then, is do the languages of the world lean toward the Pikean model represented by (1) above, or to the model represented in (2) and (3), or to a compromise between the two? Moreover, can this question be answered when these models represent claims about an abstract phonetic space which cannot be directly observed? Perhaps more than with many other phonetic parameters, there are difficulties in determining whether tone levels are maximally separated or not because of the inherently relative nature of pitch contrasts, and the large number of influences which affect realization of tones in particular contexts. Some idea of the spacing of tones can be gained from comparing the intervals between fundamental frequency measurements reported for tones in a variety of instrumental studies (as in Maddieson, 1978). However, this

technique is unsatisfactory, since there is no control for individual characteristics of speakers, and the contexts of the tones measured differ from study to study. Differences of experimental technique and measurement procedures introduce other factors which can affect the reported values. Consequently an interval between tones of, say, 15Hz in one study may not be equivalent to an interval of 15Hz in another case. While multi-speaker studies with a standardized set of techniques would provide a way round this problem, there are other strategies that can be used. Two possibilities are to examine the treatment of tones in loanwords which have been taken from one language into another, and to examine the phonetic relationships between the tones in the two languages of people who are bilingual speakers of tone languages with differing numbers of levels.

2 Tone loans

When words from a language with fewer level tones are borrowed directly into a language with more tones, the loan correspondences between tones will show which intervals are treated as equivalent. As an illustration, consider a disyllabic word with a High-Low sequence in a language with only two level tones which is borrowed into a language with three level tones. In the three level system, the tones of this word might be treated as spanning the full range from High to Low, as in (4a), or as only spanning part of the range, either High to Mid (as in 4b) or Mid to Low (as in 4c).

(4)

	2 level language		3 level language
a)	HL	→	HL
b)	HL	→	HM
c)	HL	→	ML

If the result of such borrowing is reliably as in (4b) or (4c) then the interval between High and Low in the two level language is be-

ing treated as a smaller interval than the High to Low interval in the three level language. A theory which proposes a standard interval between neighbouring tone heights, as in (2), predicts this equivalence better than one which proposes maximal separation. On the other hand, if the result is as in (4a), then the evidence favours a Pikean view, as in (1), since it indicates that the two tones of the two level system are separated as widely as the most widely spaced tones in the three level system. By examining loanwords between a number of pairings of languages it should be possible to determine if there is a consistent tendency for one or the other of these views to be confirmed.

Note that since this technique involves examination of the phonological tones of the loanwords rather than any measurement of pitch, the normalisation of individual differences is implicit in the data. An agreed perception of the tones of the donor language has been reached in the process of assigning a phonological representation to the words which have been adopted in the receiving language. Nonetheless, the technique must be used with appropriate caution. In order to be reasonably sure that a general principle is being observed, rather than some quirk applying to a particular pairing of a donor and a recipient language, it is desirable to have the same language represented as the donor in more than one pairing, the same language represented as the recipient in more than one pairing, and some pairings that are quite independent of each other (i.e. contain no language in common with each other). There are important considerations of adequacy of data involved too. A sufficient number of words is needed to assure that the equation between tones can be reliably established. The phonological structures of the languages concerned must be well enough known that misleading equations are not deduced. It must be ascertainable that the words in question are in fact loanwords and not historically related cognates, and that the direction of borrowing is known. The circumstances of borrowing must be such that the form of loanwords is likely to be based on general familiarity with the spoken version of the donor language, rather than based on an indirect channel of transmission.

Relatively few cases appear to satisfy these requirements. I know of no appropriate data available from American tone languages, though it is surely possible that there are Apachean loanwords in Tanoan languages, or Yucatec loanwords in Otomanguean languages. Data from Asian tone languages requires different handling for the most part since in many cases the tonal inventories include contour tones and strong co-occurence restrictions between segments and tones. As a result, the data reported here is drawn from African languages, where pairs of languages belonging to different major language families are involved.[1]

We will first examine loanwords from Hausa, a language in the Chadic branch of the Afro-Asiatic family, spoken principally in northern areas of Nigeria and adjoining parts of Niger. It was the language of the most influential political units in these areas in the nineteenth century (Forde 1967). Subsequently it became an official language of the Northern Region of Nigeria during colonial times and the early years of Nigeria's independence, and it has retained that status in several of the states into which the former Northern Region is now divided. Hausa has for some time played an important role in trade, religion, education and administration in the general area (Adamu 1978), serving as a lingua franca for speakers of the very large number of other languages of the region (Kirk-Greene 1967). Consequently, many languages have loanwords from Hausa. We will describe the patterning in three of these — Gwari, Nupe and Kpan — which all belong to the Niger-Kordofanian language family (Greenberg 1963).

Hausa has two level tones, High (H) and Low (L) (Abraham 1959). The sequences of these tones that are permitted in words are relatively unrestricted but words with some patterns, such as LL, are rare and others may be typical only of certain grammatical categories, such as plural nouns. There are no significant co-occurrence restrictions between tones and segments of particular types. A third tone has often been recognised: this is a falling tone that usually

[1] The limitation to African data is perhaps appropriate in the context of this volume, since it was Jack Carnochan who introduced me to tonology of African languages, as well as to experimental phonetics.

appears with a short vowel (often the vowel concerned is followed by a consonant cluster or geminate consonant, in which case a short vowel is obligatory). On various grounds this falling tone is convincingly analysed as a sequence of the High and Low tones on a single syllable. For example, the falling tone behaves like a H + L sequence in relation to the processes of downdrift/downstep and high raising. Meyers (1976) has shown that downdrifting applies to a sequence of like tones (i.e. a string of all H or all L). She calls the rule Like-Tone Lowering. However, when H and L tones alternate in sequence a steeper lowering pattern occurs, which may be labelled downstep. The falling tone fits into the same downstep pattern as disyllabic alternating H + L sequences. High Tone Raising increases the pitch of the last of a series of two or more contiguous high tones before a following low tone. When a falling tone follows one or more H tones, the same raising of the beginning of the fall can be observed. This is illustrated schematically in (5).

(5)

H H L H	H HL H
sá:bón gàrí "new town"	fítôwá "coming out"

The phonetic output of high tone raising and like tone lowering will be shown to have some importance in the loaning of Hausa words.

Gwari. The first borrowing language examined is Gwari. Hausa loanwords in Gwari have been extracted from Hyman and Magaji (1970)[2]. In this and the other cases below, the tones of the Hausa

[2]A detailed list of the relevant words for this pair of languages is given in an appendix to an earlier informal version of this paper (Maddieson 1977). Similar lists are given for the other pairs of languages, but note that the wordlist for the Tswana/!Xũ pair does not reflect extensions and corrections kindly provided by Jan Snyman and Daan Lombard, Department of African Languages, University of South Africa.

words which have been borrowed are cited as given by Abraham (1962). The Gwari dialect represented is that of Kuta, a city-state which maintained effective political independence until the end of the nineteenth century, despite owing allegiance to the Hausa Sarkin Zazzau at Zaria and later at Abuja. Close contact with Hausa would undoubtedly have existed in more northerly Gwari-speaking areas earlier than in Kuta (Temple 1919, Hiskett 1984) and it is possible that some Hausa words would have entered Kuta speech from these dialects rather than directly from Hausa. There is no reason to expect tonal patterns to be modified in borrowing between the dialects.

There are three basic level tones in Gwari, High (H), Mid (M) and Low (L). All possible sequences of tones are found, although the vocalic prefixes of nouns may only bear L or M. As most Hausa words are consonant initial, this restriction has very little impact on the pattern of borrowing. A lowered variant of mid tone occurs following a low tone, and as the realisation of mid tone in a word-initial syllable followed by H. There are some exceptional cases in which a lowered mid tone is heard on the second syllable of a word even when no low tone precedes, or where a level high tone is heard even when a low tone does precede, but these exceptional tone patterns generally do not occur on loanwords from Hausa and can be ignored for our purposes.

The pattern of borrowing of Hausa words into Gwari is summarised in table 1. In the table, as in the other ones which follow, the tone patterns of the donor language are listed in the first column. These are grouped into level, descending, rising, and (if relevant) compound groups. Parentheses are used to abbreviate related tone patterns with differing numbers of syllables. The tone patterns in the borrowed forms are listed in the second column. The third column contains the number of borrowings with the given tone pattern in the recipient language. If all loans from a particular pattern have the same tone pattern in the recipient language, there will only be one row per pattern. In other cases, two or more variant patterns may be shown, or a most typical pattern is shown with the remain-

Table 1: Hausa loans in Gwari: Correspondences between tone patterns.

	Hausa	Gwari	number
level patterns	H H (H (H))	M M (M (M))	11
	L L	L L (L)	2
descending patterns	H L	H M	8
		M L	3
		others	4
	H H L	M H M	5
		others	1
rising patterns	L H	L M	11
		others	5
	L L H	L L M	6
	L H H	L M M	6
		others	2

ing words listed as others. In such a case, the 'other' patterns are clearly minor or are such that it is hard to equate them with that of the donor language.

From table 1 it can be seen that, with few exceptions, the interval between H and L in Hausa is treated as equivalent to the interval between neighbouring tones in Gwari, either H and M or M and L. Hausa H L words usually become Gwari H M words; Hausa L H words become Gwari L M words. H in Hausa words with no low tones is borrowed as Gwari M. The only salient irregularity appears in the final two syllables of Hausa H H L words, which are borrowed as Gwari M H M, rather than the expected M M L. This irregularity can be explained as a result of the syntagmatic effects of the high-tone raising rule in Hausa described above. This rule raises the second H in the H H L sequence so that an interval is created between the first and second H. Gwari represents this as a step up from M to H,

and then represents the following H L interval as a step down from H to M, just as in the disyllabic case.

Nupe. Nupe is a language fairly closely related to Gwari and spoken in an adjoining area to the west. Although trade with Hausaland dates from earlier times, extensive direct contact with the Hausa language probably did not occur before the reformist Islamic Sokoto Caliphate to the north had consolidated its influence over Nupeland in the mid nineteenth century (Nadel 1942, Mason 1970). Consequently, Hausa loanwords in Nupe and Gwari are independently borrowed well after the separation of the two languages.

The Nupe tone system has three level tones (Smith 1967, George 1970). Contour tones arising from contraction of level tones also occur in certain contexts. An important rule produces a rising variant of H after L when a voiced consonant intervenes. Tone combinations are unrestricted except that the noun prefix /e-/ may only have L or M. The Hausa loanwords in Nupe have been extracted from Hyman (1970). A summary of the tone correspondences is given in table 2.

It is obvious that the well-represented Hausa H L and L H patterns are normally borrowed into Nupe as H M and L M respectively, that is, as the smaller of the two possible intervals available in the phonology of the recipient language. Also Hausa H in words with only H tones corresponds to Nupe M. However, in words with a Hausa tone pattern that contains both an ascending and a descending interval, such as L H L or H L H, it is not uncommon for one of these intervals to be represented as a 'single step' between tones in Nupe and for the other to be represented by a 'double step'. Thus the usual borrowings of Hausa L H L and H L H are Nupe L H M and H L M respectively. In the latter case the Hausa downstep rule probably provides an explanation. This rule ensures that in H L H words a markedly smaller pitch interval separates the medial L from the final H than separates the initial H from L, i.e. in Hausa H L H is schematically |‾_—| (in fact, final H after L can be even lower than shown here, Meyers 1976, Lindau 1986). Nupe has no comparable

Table 2: Hausa loans in Nupe: Correspondences between tone patterns.

	Hausa	Nupe	number
level patterns	H H	M M (M)	5
descending patterns	H L	H M	7
	H H L	H H M	2
		others	1
rising patterns	L H	L M	5
		others	2
compound patterns	L H L	L H M	7
		others	6
	H L H	H L M	8
		others	1

downstep rule, so the H L M pattern probably represents an attempt to capture the difference between the Hausa H L and L H intervals *when they appear together in the same word.*

In the two words where the Nupe pattern corresponding to Hausa L H L is M H L a similar explanation could apply, since Hausa L H L = |—‾_|. But the more common pattern for Hausa L H L is Nupe L H M. This is puzzling in view of the clear preference for the ascending interval L H in Hausa to be represented as L M in Nupe. And the Nupe L H M pattern cannot be accounted for as capturing the output of tone rules in Hausa. Apart from this unexplained correspondence, the general tendency of the Nupe data, as for Gwari, is also to provide evidence against a maximal spacing hypothesis for tones.

Kpan. A third language into which Hausa borrowings have been taken is the Jukunoid language Kpan, spoken well to the east of the

Table 3: Hausa loans in Kpan: Correspondences between tone patterns.

	Hausa	Kpan	number
level patterns	H H	H H	2
		others	1
	H H H	M M M	2
	L L (L)	L L (L)	4
descending patterns	H L	H L	3
		M L	2
		others	4
rising patterns	L H	L M	3
		others	3
	L L H	L L H	2
		others	1
	L H H	L M M	2
compound patterns	L H L	L M L	2
		others	3

Hausa heartland. The Kpan were included in the Jukun empire of Kororofa, subsequently conquered from the east by the Chamba and partially under the control of the Fulani emirate of Adamawa until colonial times (Meek 1931a, b, Hiskett 1984). Hausa loans in this language are almost certainly of recent origin, having entered the language in the present century because of the status of Hausa as an officially recognised language. The Hausa loanwords in Kpan have been extracted from Shimizu (1972). Shimizu (1971) describes the tone system of Kpan as one with three level tones. The three tones may combine freely in all possible sequences, although the prefix vowels of nouns are generally L before L or M and M before H. A summary of the tonal correspondences of Hausa words in Kpan is given in table 3.

There is inconsistency in representing the Hausa interval between tones as the smaller or the larger of the two options available in Kpan. There is also inconsistency in the way that words with only High tones are borrowed: the two H H words are borrowed as H H but the two H H H words are borrowed as M M M. However, if the numbers of ascending and descending intervals in Hausa represented in Kpan as 'one step' and 'two step' intervals are separately totalled, a distinct preference for the one step interval is found. Of the cases where an ascending interval is included in the Hausa tone pattern (L H, L L H, L H L, etc), thirteen move up one step in Kpan (from M to H or from L to M) and only five move two steps up (from L to H). Of the descending patterns in Hausa, ten move one step down in Kpan while eight move two steps down. At least some of these two-step drops can be understood as resulting from the Hausa High Tone Raising rule, particularly in the case of Hausa H H L and H H H L patterns becoming Kpan M H L and M M H L respectively. The interval from the Hausa raised H to the following L is represented by a two step in Kpan, but between the initial M tone and the final L in Kpan there is only a single step. It seems appropriate to consider at least these two patterns are representing the Hausa H . . . L difference esentially as Mid to Low in Kpan. This produces the totals shown in (6).

(6)

	interval = one step	interval = two steps
ascending	13	5
descending	12	6
Total	25	11

These numbers make it clear that it is prevalent for the Hausa interval between tones to be treated as equivalent to the interval between H and M or between M and L in Kpan. A theory of maximal separation of tones is less successful in predicting this pattern than a theory that posits a standard separation between adjacent tones.

!Xũ. The loans from Hausa into Gwari, Nupe and Kpan fulfill the requirement that loans from the same source into a number of dif-

ferent languages should be examined. This is one way to provide a check against correspondences that result from, say, a fortuitous coincidence of subsidiary phonetic properties of tones in a given pairing of language. Another way of providing the same check is to find instances where a given language has borrowed from more than one language. Southern Africa provides an example of this type, involving borrowing from two different Bantu languages into the Zu|'hõasi dialect of !Xũ, a Khoisan language spoken in Namibia. The number of words is not large, but the case is particularly interesting because of the four-tone system of !Xũ. Snyman (1975) labels these four tones Extra High (EH), High, Mid and Low. There are minimal contrasts between all four and most sequences are found to occur. The M tone is the most frequent in the vocabulary that Snyman has examined, followed in descending order of frequency by H, L and EH.

The first source of borrowed words in !Xũ is the Sotho-Tswana group of dialects, which have two level tones like the majority of Bantu languages (Krüger and Snyman 1986). Contact has been principally with Tswana members of this group, speakers of !Xũ and Tswana having been involved in recent times in a kind of master-serf relationship (Silberbauer and Kuper 1966). In addition, workers from both languages have often been employed together on farms in Namibia. The loanwords have been extracted from Snyman's !Xũ-Afrikaans dictionary, which identifies the Tswana source items but does not mark their tones. Tone-patterns for Tswana words have therefore been sought in appropriate places (e.g. Cole and Mokaila 1962, Cole 1969, Jones 1927, 1928, Tucker 1929) and checked against data kindly provided by Jan Snyman and Daan Lombard (p.c.). The resulting tone correspondences are summarized in table 4.

None of the !Xũ loanwords contains an EH tone, which might have been expected if maximal separation was the rule. Words with ascending (LH) tone pattern in Tswana are borrowed with a !Xũ tone sequence with an interval of one step, i.e. as either MH or LM. The loanwords which have descending intervals in Tswana seem once more to reflect the operation of tone rules in the donor language. An important rule in Tswana raises L to H after H in many environments

Table 4: Sotho-Tswana words in !Xũ: Correspondences between tone patterns.

	Sotho-Tswana	!Xũ	number
level patterns	L L (L)	M M (M)	5
		L L (L)	3
		others	1
descending patterns	H L	H H	3
		H M	2
		others	1
risng patterns	L H	L M	5
		M H	3

(Cole 1969, Krüger and Snyman 1986). The three Tswana HL words which come into !Xũ as HH are fairly straightforwardly derived from forms to which the rule HL → HH has applied.

The second donor language from which borrowings into !Xũ are noted by Snyman is Herero. Herero is from quite a different subgroup of Bantu than Sotho-Tswana, but it also has a tone system with two level tones (Köhler 1958, von Essen 1971). Unfortunately, although several Herero dictionaries are available (Kolbe 1883, Brincker 1886, Irle 1917, Meinhof 1937, Viljoen and Kamupingene 1983) none of them mark tone. The original tone patterns on the Herero words borrowed into !Xũ are unknown at present. However, it is still possible to observe that none of the loanwords has EH tone in !Xũ and in general there is no more than one step between the tones that they bear.[3]

[3]These conclusions concerning !Xũ/Bantu comparisons are reinforced by an observation by Lanham and Hallowes (1956). On the basis of contrast they recognise three level tones in what they call Eastern Bushman, a language related to !Xũ that is spoken in South Africa. They then additionally argue that

The treatment of tone loans across the set of cases studied here is quite consistent with the view that tones are separated by a 'standard' interval adequate for them to be distinguished from each other, rather than being maximally separated. Conclusions based on loan comparisons can be complemented by data from the second technique suggested at the outset of this paper.

3 Bilingual speakers

A more strictly experimental strategy for studying the principles which govern tone spacing is to look at the relationship between the tones of bilingual speakers who speak two tone languages. Because the speakers are the same individuals, variation due to personal factors is eliminated. The present study concerns five male African students or teachers who are speakers of (at least) one language with two level tones and one language with three level tones, and had learned both languages in relatively early childhood.[4] Although one language was still considered the 'mother tongue' as the main language of the parental home, in several instances the subject was now more at ease in the other of his languages. All subjects also knew English.

Minimal or near-minimal sets of words containing the contrasting tones of the languages involved were selected. These were matched for segmental composition as far as possible across each pair of languages spoken by any subject. The words were embedded in similar

> "... another factor lending support to the recognition of three level tonemes is the unusually big fall from the tones marked as high tones ... to those marked as low tones. This fall is noticeably greater than that heard between the high and low tones in Nguni and Sotho (with their ditonemic structure)..."

[4] I am most grateful to the subjects who participated in this experiment for their time and patience. This project could not have been completed without the assistance in making contacts from Linda Hunter, Department of African Languages, University of Wisconsin.

positions in sentences of equal length and similar tone patterns in the two languages. A reading list of sentences for each language containing these 'target' sentences as well as others was then prepared and the subject was rehearsed in reading the relevant lists. Each subject then read each of the two relevant lists a number of times under good acoustic conditions while a tape recording was made.

Narrow band spectograms were made of (usually) six tokens of each utterance containing the items selected for tonal comparison. The fundamental frequency (F_0) at the mid point of the appropriate vowel was calculated from the frequency of the highest clearly visible harmonic. The results are summarized in Tables 5-7, which list the words used for each subject, number of tokens, the standard deviation and mean F_0 in Hz of the tones on these words. In the final column the differences between tones are given, rounded to the nearest whole number. The five comparisons in these tables show that in each case the difference between the tones in the two-level language is substantially smaller than that between the High and Low tones of the three-level language.

Two of the speakers, IS and IGM, were speakers of Nupe and Hausa, one of the language pairs in the previous section. Both speakers' 'mother tongue' is Nupe. Results from the bilingual study for these two subjects are given in Table 5. These confirm the phonetic basis for the patterns noted in loanword phonology. The High–Low difference in Nupe is about double that measured for the same speakers speaking Hausa. A similar degree of difference is seen between the two languages of speaker MEI speaking Edo and Yoruba, and of speaker IK speaking Hausa and Jaba. MEI is a 'mother tongue' speaker of Edo, IK is a 'mother tongue' speaker of Jaba. Results for these two subjects are given in table 6. For the four subjects in tables 5 and 6 it is reasonable to posit a more or less constant interval between a pair of most-similar tones, and to explain the language difference as resulting from the use of two such intervals in the three-level language. Note that the size of such an interval can be markedly speaker-dependent; subject IK has an unusually low voice with a narrow range but has a consistent interval between adjacent

Table 5: Hausa/Nupe bilingual speakers.

Subject	Language	Word	n	s.d.	Mean (in Hz)	Difference(s)
IS	Hausa	gádó:	6	2.03	117	22
		gá:dò:	5	4.92	95	
	Nupe	tsāmā[a]	6	1.99	135	14, 36
		ēdū	6	3.1	121	23
		ēdū	6	6.62	99	
IGM	Hausa	gádó:	6	5.13	128	17
		yárò:[b]	5	4.16	111	
	Nupe	ēdū	6	3.77	134	15, 37
		ēdū	6	3.72	120	22
		ēdū	6	2.92	97	

[a]This speaker did not pronounce the expected tone pattern for the word selected for minimal contrast. Instead a word with final high tone but a low vowel was selected. To the extent that low vowels tend to lower pitch, this substitution tends to work against the hypothesis of this paper.

[b]This speaker did not produce the high-low pattern on the original word selected here, so a word of similar structure was measured.

Table 6: Two additional comparisons of tones of bilingual speakers.

Subject	Language	Word	n	s.d.	Mean (Hz)	Differences
MEI	Edo	áró	6	4.12	139	18
		àrò	8	5.81	121	
	Yoruba	óró	6	3.86	145	22
		ōrō	6	2.6	123	20
		òrò	6	9.81	103	42
IGM	Hausa	háu∫í	6	1.76	87	8
		háu∫ì	7	4.16	79	
	Jaba	dzíī[a]	6	3.04	103	9
		dzìdzī	6	1.53	94	9
		tsì[b]	6	2.65	85	19

[a] This item has a high to mid tone glide in the final syllable. The peak of the high tone part was measured.

[b] A minimal contrast could not be found, so an item with a voiceless initial consonant was accepted. Since a voiceless initial might raise the measured low tone frequency, this choice works against the hypothesis of this paper.

tones of about half the size of the other subjects.

The remaining comparison, speaker JN producing Akan and Adangme, shows a narrower difference between the ranges used in the two languages. This set of data, shown in table 7, seems to differ from the other comparisons mainly because the interval between the two tones in Akan is larger than might have been expected. However, this pair of languages might not provide a clear case of comparison between two and three tone systems. It could be that Akan has effectively moved much of the way toward having the phonetic characteristics of a three-level language through the incorporation of lexical downsteps into a sufficiently large number of forms (Dolphyne 1988). Conversely, although Adangme has three contrastive tones in monosyllables and elsewhere, contrast between mid and low is neutralised in some environments (Kropp Dakubu 1974). These

Table 7: Akan/Adangme bilingual comparison.

Subject	Language	Word	n	s.d.	Mean(Hz)	Differences
JN	Akan	dí	5	5.31	136	} 29
		dì	8	5.81	107	
	Adangme	óró	6	3.59	134	} 23 } 39
		òrò	6	2.6	110	} 16
		òrò	5	1.27	95	

considerations may reduce the relevance of this comparison for the purposes of this paper.

4 Conclusions

The examination of the relative spacing of level tones using two strategies — examination of tone loans and bilingual speakers — indicates that tones are not separated according to a maximal spacing principle, at least not when comparison of two-level and three-level tone systems is at issue. These data are consistent with the view that they are instead separated by a relatively standard interval which does not depend on the number of tones being contrasted. This interval might perhaps be expressed as some proportion of the speaker's total pitch range. It is not certain that this finding can be generalised to systems with four or five level tones, since only one language concerned has a fourth level, namely !Xũ. Although no Extra High tones are found in the loanwords in !Xũ, this might be a reflection of the low lexical frequency of this tone. On this basis it is not certain that the compromise position described in the introduction, suggesting that spacing will be different in four and five level systems, can be ruled out.

To the extent that a general principle of phonetic spacing can be projected from these results, it is that normally a larger number

of contrasting elements will occupy a larger phonetic space than a smaller number. However, different phonetic subsystems may differ in the way that this expansion is achieved. A phonetic space can be enlarged by use of more extreme values of given parameters, or by adding new dimensions of contrast. Tone systems seem to first exploit more extreme values of a pitch dimension. Other studies indicate that use of pitch is limited to a maximum of five contrastive levels. More elaborate tone systems add contrasts of pitch direction and slope (Maddieson 1978, 1979). On the other hand, consonant systems may typically expand the phonetic space by directly adding new parameters of contrast (Lindblom and Maddieson 1988), and vowel systems show tendencies both to add parameters and to reduce the spacing between their members as the number increases above about five. Only unusually small vowel systems, with less than five members, seem to use less than the full range of values of the most basic parameters of vowel quality (Disner 1983, Maddieson 1989). The pattern seen in tone systems may be primarily a result of the fact that they most typically contain a small number of members.

A further striking result of the analysis of the tone loans is that borrowing is often shaped by the surface phonology of the donor language. This is in contrast to the view put forward by Hyman (1970), who argued that borrowing is based on underlying forms. Apart from the effects of tone rules noted earlier, another prosodic effect seems to be reflected in Tswana borrowings into !Xũ. Tswana has a penultimate stress rule by which the vowel in the stressed syllable is lengthened and may have a rising pitch onset. The shape of one loanword in which the H syllable of a Tswana disyllabic HL word is reflected as a geminate vowel with a rising tone contour in !Xũ seems to be based on this phonetic pattern in the donor language. This word is given in (7).

7)

Tswana	!Xũ	gloss
thótà	tùuta	"hill"

The original final L also seems to show the effects of Low Raising in Tswana, as in !Xũ the final tone is of the same level as the end of the rising contour on the long vowel. When borrowing is based on direct familiarity with the donor language, and not mediated by the influence of orthograpy or pseudo-historical factors, surface forms might be expected to be the normal model for loanwords.

The importance of this fact was recognised by Newman (1984) in discussion of Gwandara. Gwandara is recognised as the closest relative to Hausa (Newman 1977), but has three rather than two tones. It shows a similar relationship between its tones and Hausa tones as is seen between Hausa and Nupe or Gwari tones. Newman comments that "The Gwandara tonal system seems to have resulted from the reinterpretation of Hausa surface tones in terms of the tone spacing grid of a language or languages having three tones." As Newman points out, ethnohistorical accounts describe the Gwandara as Hausa people who fled from Kano rather than accept Islam. These accounts seem to allow inadequate time depth for the degree of divergence between Kano Hausa and Gwandara to have developed by the normal processes of linguistic evolution. However, if such refugees formed the nucleus of communities whose other members were non-native speakers of Hausa, the divergence between Hausa and Gwandara can be accounted for by creolisation. Under these circumstances the processes seen in loan phonology might be expected to shape the outcome, such as the observed relationship between the tones.

REFERENCES

Abraham, R. C. 1959. *The Language of the Hausa People*. University of London Press, London.

Abraham, R. C. 1962. *Dictionary of the Hausa Language (2nd ed.)*. University of London Press, London.

Adamu, Mahdi. 1978. *The Hausa Factor in West African History*. Ahmadu Bello University Press, Zaria.

Brincker, H. 1886. *Wörterbuch und kurzgefasste Grammatik des Otji-Herero (mit Beifügung verwandter Ausdrücke und Formen des Oshi-Ndonga, Otj-Ambo).* C. G. Büttner, Leipzig (Reprinted by Gregg, Ridgewood N.J., 1964).

Chao, Yuan-Ren. 1930. "A system of tone letters." *Maître Phonétique* 30: 24–27.

Cole, Desmond T. 1969. "Tonal morphology in Tswana." In *Ethnological and Linguistic Studies in Honour of N. J. van Warmelo.* Department of Bantu Administration and Development, Pretoria: 39–45.

Cole, Desmond T. and D. M. Mokaila. 1962. *A Course in Tswana.* Georgetown University, Washington, D.C.

Disner, Sandra F. 1983. *Vowel Quality: the Relation between Universal and Language-Specific Factors (UCLA Working Papers in Phonetics 58).* Phonetics Laboratory, University of California, Los Angeles.

Dolphyne, Florence A. 1988. *The Akan (Twi-Fante) Language.* Ghana Universities Press, Accra.

Forde, C. Daryll. 1967. *West African Kingdoms in the Nineteenth Century.* Heinemann, London.

George [Madugu], Isaac. 1970. "Nupe Tonology." *Studies in African Linguistics* 1: 100–122.

Greenberg, Joseph H. 1963. *The Languages of Africa.* University of Indiana, Bloomington.

Hiskett, Mervyn. 1984. *The Development of Islam in West Africa.* Longman, London and New York.

Hombert, Jean-Marie. 1978. "A model of tone systems." In *Elements of Tone, Stress and Intonation,* ed. D. J. Napoli. Georgetown University Press, Washington, D.C.: 129–143.

Hyman, Larry M. 1970. "The role of borrowing in the justification of phonological grammars." *Studies in African Linguistics* 1: 1–12.

Hyman, Larry M. and Daniel J. Magaji. 1970. *Essentials of Gwari Grammar (Occasional Publication 27).* Institute of African Studies, University of Ibadan, Ibadan.

Irle, J. 1917. *Deutsch-Herero Wörterbuch (Abhandlung des Hamburgischen Kolonialinstituts 32, Reihe B 18).* Friederichsen, Hamburg.

Jaeger, Jeri J. and Robert Van Valin, Jr. 1982. "Initial consonant clusters in Yatée Zapotec." *International Journal of American Linguistics* 48: 125–138.

Jones, Daniel. 1927. "Words distinguished by tone in Sechuana." In *Festschrift Meinhof*. Friederichsen, Hamburg: 88–98.

Jones, Daniel. 1928. *The Tones of Sechuana Nouns (Memorandum 6)*. International Institute of African Languages and Cultures, London.

Kirk-Greene, A. H. M. 1967. "The linguistic statistics of Northern Nigeria: a tentative presentation." *African Language Review* 6: 75–101.

Köhler, Oswin. 1958. "Tongestalt und Tonmuster in Infinitiv des Verbum in Herero." *Afrika und Übersee* 42: 97–110, 159–172.

Kolbe, F.W. 1883. *An English-Herero Dictionary (with an Introduction to the Study of Herero and Bantu in General)*. J. C. Juta, Cape Town.

Kropp Dakubu, Mary Esther. 1974. "Some features of tone in Dangme." *Journal of West African Languages* 9: 79–86.

Krüger, C. J. H. and Jan W. Snyman. 1986. *The Sound System of Setswana*. Via Afrika, Goodwood, South Africa.

Lanham, L. W. and D. P. Hallowes. 1956. "An outline of the structure of Eastern Bushman." *African Studies* 15: 97–118.

Liljencrants, Johan and Björn Lindblom. 1972. "Numerical simulation of vowel quality systems: the role of perceptual contrast." *Language* 48: 839–862.

Lindau, Mona. 1986. "Testing a model of intonation in a tone language." *Journal of the Acoustical Society of America* 80: 757–764.

Lindblom, Björn. 1988. "Models of phonetic variation and selection." Proceedings of conference on *Language Change and Biological Evolution*. Institute for Scientific Interchange, Turin.

Lindblom, Björn and Ian Maddieson. 1988. "Phonetic universals in consonant systems." In *Language, Speech and Mind*, ed. by L. M. Hyman and C. N. Li. Routledge, London and New York: 62–78.

Maddieson, Ian. 1977. "Tone loans: a question concerning tone spacing and a method of answering it." *UCLA Working Papers in Phonetics* 36: 49–83.

Maddieson, Ian. 1978. "Universals of tone." In *Universals of Human Language, Vol. 2: Phonology*, ed. J. H. Greenberg et al. Stanford University Press: 335–365.

Maddieson, Ian. 1979. "Dimensions of tone systems." *Proceedings of the Ninth International Congress of Phonetic Sciences, Copenhagen,*

1979, Vol. 1: 389. Institute of Phonetics, University of Copenhagen. (Summary only; full text in *UCLA Working Papers in Phonetics* 57: 121–131 (1980))

Maddieson, Ian. 1984. *Patterns of Sounds*. Cambridge University Press, Cambridge.

Maddieson, Ian. 1989. "Patterns of sounds: Observations on the design of languages." Paper presented at the Fifth Conference of the African Language Association of Southern Africa, to appear in the Association's *Journal*.

Mason, M. D. 1970. *The Nupe Kingdom in the Nineteenth Century*. Ph. D. thesis, University of Birmingham.

Meek, C. K. 1931a. *A Sudanese Kingdom; an Ethnographical Study of the Jukun-speaking peoples of Nigeria*. Kegan Paul, Trench, Trübner, London.

Meek, C. K. 1931b. *Tribal Studies in Northern Nigeria, Volume II*. Kegan Paul, Trench, Trübner, London.

Meinhof, Carl. 1937. *Die Sprache der Herero in Deutsche Südwestafrika (2nd ed.) (Deutsche Kolonialsprachen 1)*. Reimer, Berlin.

Meyers, Laura. 1976. *Aspects of Hausa Tone (UCLA Working Papers in Phonetics 32)*. Phonetics Laboratory, UCLA, Los Angeles.

Nadel, S. F. 1942. *A Black Byzantium*. Oxford University Press, Oxford.

Newman, Paul. 1977. *Chadic Classification and Reconstruction (Afroasiatic Linguistics 5.1)*. Undena Publications, Malibu.

Newman, Paul. 1984. "Tone splitting and Gwandara ethnohistory." *Studies in African Linguistics, Supplement 9 (Précis from the 15th Conference on African Linguistics, UCLA)*: 233–237.

Pike, Kenneth L. 1948. *Tone Languages*. University of Michigan Press, Ann Arbor.

Shimizu, Kiyoshi. 1971. "The Kente dialect of Kpan: I Phonology." *Research Notes (Department of Linguistics and Nigerian Languages, University of Ibadan, Ibadan)* 4.2/3: 11–36.

Shimizu, Kiyoshi. 1972. "The Kente dialect of Kpan: III Lexicon." *Research Notes (Department of Linguistics and Nigerian Languages, University of Ibadan, Ibadan)* 5.1: 1–67.

Silberbauer, G. B. and A. J. Kuper. 1966. "Kgalagari masters and Bushman serfs: some observations." *African Studies* 25: 171–179.

Smith N. V. 1967. "The phonology of Nupe." *Journal of African Languages* 6: 163–169.

Snyman, Jan W. 1975. *Zu|'hõasi Fonologie en Woordeboek*. Balkema, Cape Town.

Temple, O. 1919. *Notes on the Tribes, Provinces, Emirates and States of the Northern Province of Nigeria*. Church Missionary Society, Cape Town. (Reprinted by Cass, London, 1965).

Tucker, A. N. 1929. *The Comparative Phonetics of the Suto-Chuana Group of Bantu Languages*. Longmans, London.

Viljoen, J. J. and T. K. Kamupingene. 1983. *Otjiherero Woordeboek-Dictionary-Embo Romambo*. Gamsberg, Windhoek.

Von Essen, Otto. 1971. "Bedeutungsbestimmende Silbentonhöhen in der Sprache der Herero." In *Afrikanische Sprachen und Kulturen — Ein Querschnitt*, ed. V. Six et al. Deutsches Institut für Afrikaforschung, Hamburg: 88–94.

Wang, William S. Y. 1967. "The phonological features of tone." *International Journal of American Linguistics* 33: 93–105.

Westermann, Dietrich and Ida C. Ward. 1933. *Practical Phonetics for Students of African Languages*. Oxford University Press for the International African Institute, London.

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